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AUTHOR	Berman, Phyllis W.
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ABSTRACT

The two experiments investigated stimulus novelty which may affect reward and nonreward in a discrimination learning situation at different ages. The first experiment compared two types of "trial one" stimulus procedures on error tendencies following reward and nonreward. The two procedures differed with respect to novelty effects. One group was presented on the first trial with one of the two "trial two" stimuli, while the other group was given two stimuli on both trials. Reward was more difficult for the "one stimulus" group. In the second experiment, two groups were given a series of 24 problems with varied presentation to alter familiarity with the stimuli. One group chose between a novel and a familiar stimulus with the familiar stimulus rewarded half of the time and nonrewarded the other half. The other group was given stimuli but did not know whether its choices were rewarded. The first group chose familiar stimuli more often than the second group suggesting that the learning situation was more favorable. Results were specific to the use of "two dimensional" patterned stimuli which have little tactual appeal to children. (EK)

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ERRORS DURING CHILDREN'S DISCRIMINATION LEARNING: STIMULUS AND PROCEDURAL EFFECTS

Phyllis W. Berman
Pennsylvania State University
University Park, Pa. 16802

January 1970

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SUMMARY

Experiment 1 compared the effect of two types of trial-1 stimulus presentation procedures on error tendencies following reward and nonreward. The two procedures differ with respect to novelty. A learning-set series of 48 2-choice 2-trial problems was administered to 32 children. The tendency to make errors following reward and nonreward was compared using two groups. One group was presented on the first trial with only one of the two trial-2 stimuli. The other group was given two stimuli on both trials. The reward problem was significantly more difficult than the nonreward problem for both groups. As expected, reward was more difficult for the 1-stimulus group than for the 2-stimulus group. However, contrary to prediction, nonreward was also more difficult for the 1-stimulus group. It appears as though the additional information available to subjects with the 2-stimulus procedure was enough to offset the effect of novelty which was expected to make the correct stimulus on the nonreward problem more attractive to children in the 1-stimulus group. There was no significant difference between the two age groups (2 1/2 to 4 1/2 years, and 4 1/2 to 6 1/2 years).

In the second experiment two groups of eight children each (6 1/2 to 10 years), were given a series of 24 problems. Method of presentation of the stimuli was varied for the groups in an effort to vary familiarity with the stimuli. Group A was asked to choose between a novel stimulus and a familiar "ambiguous" stimulus which had been presented alone for either 2 or 4 consecutive trials. The familiar stimulus was rewarded on half of the single presentations and nonrewarded on the remaining ones. Group B was given 2 or 4 visual exposures to the stimulus, but had no opportunity to choose the stimulus, to handle it, or to see if its choice was rewarded. Instead the "ambiguous" stimulus was merely present while the subjects chose between two other stimuli. Both groups tended to choose the novel stimulus on initial problems. On the series of problems choice of the familiar ambiguous was rewarded, and Group A chose the familiar stimulus more often than Group B, probably because the learning situation was more favorable and learning was more efficient. Children in both groups tended to choose the familiar stimulus more often on the shorter problems than on the longer problems, but the effect was not significant.

The results of both experiments were thought to be specific to the use of 2-dimensional patterned stimuli which had little tactual appeal to children. A fuller study of the effects of stimulus properties on learning was suggested.

GENERAL INTRODUCTION

Harlow and his associates (1959) have demonstrated that various identifiable sources of error, i.e., error factors, operate during monkeys' discrimination learning. During the course of learning a series of separate but related problems these error factors diminish in strength, but at different rates. The error factors include response-perserveration, i.e., failure to shift choice after nonreward, and response-shift, i.e., failure to repeat a choice which has been rewarded.

Although most learning set studies with human subjects have been conducted with institutionalized retardates several have used normal children. The results indicate that both response-perseveration and response-shift are important sources of error in children's discrimination learning. In addition there is general agreement that young children show a particularly strong response-shift tendency, especially when the incorrect (nonrewarded) stimulus is novel.

Harlow described response-shift in monkeys as reflecting the subject's tendency to try out all the stimulus objects in the discrimination situation. The tendency may be associated with any one or more of a number of factors, depending on the experimental situation (e.g., preference for visualizing novel, rather than familiar stimuli, a tendency to explore the reinforcement potential of various alternatives in a choice situation, a drive to manipulate and explore hitherto untouched stimulus objects, etc.). The extent to which each of these factors operates in a learning situation varies with the stimulus situation, procedure, and possibly with the subject's age. If so, a learning situation which is optimal at one age may elicit many response-shift errors at another age.

The two experiments reported were designed to investigate several aspects of stimulus novelty which may affect the efficiency of reward and nonreward in a discrimination learning situation at different ages.

EXPERIMENT 1

Introduction

The first experiment compared the effect of two types of trial-1 stimulus presentation procedures on error tendencies following reward and nonreward. The two procedures differed with respect to novelty effects.

Although any number of trials per problem may be used in discrimination learning set, the first trial is usually

considered an information trial. The stimuli are changed for each problem, and the subject learns, through reward or nonreward of his initial choice, which stimulus will be rewarded. On trial 2, and on subsequent trials, he must respond to the information from trial 1 according to the principle learned on previous problems.

In Experiment I a learning set series of 2-trial 2-stimuli discrimination problems was administered to subjects of two age groups. The number of stimuli presented on the information trial was varied. One group of subjects at each age was presented with both of the problem stimuli on trial 1. Another group was presented with only one of the stimuli on the first trial.

With the 1-stimulus procedure the subject had no choice on trial 1, but he merely picked up the single stimulus presented to see if it was associated with reward. On trial 2 the same stimulus was paired with a new stimulus. Therefore, a familiar stimulus was in competition with a novel stimulus on the choice trial (trial 2).

In the 2-stimuli method both of the stimuli were presented on trial 1, and again on trial 2 after reward or nonreward of the subject's trial-1 choice. Neither stimulus was completely novel, in the sense that the subject had already seen both on trial 1. However, the stimulus chosen on the first trial was more familiar than the unchosen stimulus since the subject had an opportunity to manipulate and explore only the chosen stimulus. Moreover, although the instructions stated that only one of the two stimuli presented was correct, he had no opportunity to see for himself if the unchosen stimulus was, indeed, rewarded.

The author knows of no previous research with normal children which adequately tested the difference between the 1- and 2-stimuli presentation methods. However, several of the studies investigated the strength of response-shift and response-perseveration error tendencies, and sometimes the effect of age, using one or the other of the two methods.

Levinson and Reese (1967) gave nursery school children and 5th graders a series of 90 2-choice problems with 4 trials per problem. Both stimuli were presented on trial 1 and again on trial 2. Although both stimuli were familiar on trial 2 both age groups learned to shift choice following nonreward more readily than to repeat a correct choice after reward. Preschoolers made twice as many errors on trials following a correct initial choice as they did following an error.

Two experiments using the 2-stimuli procedure and a single problem, rather than a series, indicated that there

may be an age difference in the strength of the tendency to shift choice following reward. Berman and Graham (1964) presented a 2-trial problem to preschool subjects, using the same two stimuli on both trials. Four-year-olds repeated a rewarded choice less frequently than 2-year-olds, but the age difference was not significant. Stevenson and Weir (1961), with a 3-choice problem, found that significantly fewer errors were made by 3-year-olds following a rewarded choice than following a nonrewarded one. However, for 5-, 7-, and 9-year-olds the opposite was true. All three stimuli were presented on both trials.

Schusterman (1963) administered five 2-choice trials to 3-, 5-, and 10-year-olds. On each trial the subject's choice was rewarded although he was told that only one of the stimuli was correct on each trial. Three-year-olds repeated a choice following reward, 5-year-olds shifted choice, and 10-year-olds showed no significant trend. Both the Stevenson and Weir experiment and the Schusterman study were spatial, rather than object, discriminations with identical stimuli from which to choose, and the desire to visualize or explore stimulus characteristics would be of minor importance in this type of situation.

Berman (1965) recently conducted three learning set experiments which assessed the strength of error tendencies in 4-, 6-, 8-, and 10-year-olds during six learning sessions with a series of 2-trial problems. In the first two experiments, errors following one information trial with a single rewarded or unrewarded stimulus were related to age changes and to varying degrees of experience with reward and nonreward. In Experiment I (Berman, Rane, and Bahow; in press) children given 72 reward, and 72 nonreward, problems made significantly more errors following reward than following nonreward. Ten-year-olds learned both problems rapidly, but 4-, 6-, and 8-year-olds encountered great difficulty with the reward problem, and 4-year-olds showed no sign of learning the problem during six sessions.

In the second experiment 4- and 8-year-olds were given either 36 reward, and 108 nonreward problems, or 108 reward and 36 nonreward problems. Three times as much experience was required with the reward problem, as with the nonreward problem, for children to perform at the same level on both problems.

A third study was conducted in an attempt to compare response-shift tendencies of 4-, 6-, 8-, and 10-year-olds following the 1-, and the 2-stimuli presentation procedures. Two groups of subjects from each age group were given a series of 108 reward problems only, with either of the two methods. Children in the 2-stimuli group made more errors than those in the 1-stimulus group. However the difference between the groups appeared to be due to an artifact. Those

subjects with 2 stimuli on trial 1 had greater opportunity to develop perseverative position responses.

In both methods the subject's trial-1 choice was always rewarded. In the 2-stimuli method stimuli were placed in the right and left positions on trials 1 and 2 of each problem. Since the position of the rewarded stimulus was changed from trial 1 to trial 2 on only half of the problems, it was possible for a child to be rewarded 75 per cent of the time for a perseverative run of responses to one position.

In the 1-stimulus method a single stimulus was presented in the center position on the first trial of each problem. On trial 2 both stimuli were presented in the right and left positions. Therefore it was possible for the subject to be rewarded only 50 per cent of the time for perseverative responses to either the right or the left position.

The two groups were compared for frequency of responses which were part of position runs in proportion to the number of times when there was an opportunity to make such responses. The 2-stimuli group made significantly more perseverative position responses than the 1-stimulus group, with the 4-year-olds making most of these perseverations.

Cross and Vaughter (1966) gave children a series of 96 3-trial object discrimination problems. For one group the positive (rewarded) stimulus was presented as the single stimulus on trials 1 and 2 of each problem. Another group was presented with the negative (nonrewarded) stimulus on trials 1 and 2. The authors reported that older children (4 1/2 to 6 yrs.) made more accurate trial-3 choices when the positive (rewarded) stimulus had been presented on the first two trials. In contrast, younger children performed significantly better when the negative (unrewarded) stimulus had been presented. It is interesting that the younger group chose the novel stimulus on trial 3 more often than chance whether or not it was correct. The older group did so only when the novel stimulus was correct.

In summary, most of the research comparing response to reward and nonreward shows that young children, at least from age 4 1/2 through 8 years, have more difficulty learning to repeat a rewarded choice, than to shift choice following nonreward. This appeared to be the case, no matter which of the two trial-1 procedures was used. However, none of the studies made an adequate comparison between the learning of reward and nonreward problems using both the 1- and the 2-stimuli methods of presentation. Experiment I was designed to make such a comparison.

The following hypotheses were made. Since young children generally prefer novel to familiar stimuli (c.f., Cantor, 1963) they would be more likely to make a correct trial-2 choice when the correct stimulus was novel rather than familiar (that is on nonreward problems, rather than reward problems). Nonreward problems were expected to be easier than reward problems when presented with either the 1-, or the 2-stimuli methods. However, an interaction was expected between type of problem (reward vs. nonreward) and presentation method. Since one of the trial-2 stimuli was completely novel for the subjects with the 1-stimulus method, novelty was expected to be more influential in determining stimulus choice for the 1-stimulus group than for the 2-stimuli group. Thus, the reward problem was expected to be more difficult for the 1-stimulus, than for the 2-stimuli, group, but the opposite was expected for the nonreward problem.

With less distinctive stimuli generalization from each stimulus to the other, of excitation from trial-1 reward and of inhibition from nonreward, might operate to make both of the problems more difficult for the 2-stimuli group. However, the stimuli were chosen to be as distinctive and as discriminable as possible and pilot testing indicated that generalization was minimal.

No interaction was expected between age group and type of problem (reward vs. nonreward) although the age groups used were close to those used by Cross and Vaughter. Neither Berman's earlier experiments nor Levinson and Reese's experiments found such an interaction.

Method

Subjects. The subjects were similar in socioeconomic background to those used by Berman in her earlier experiments. They were drawn from a similar population and limited in the same manner. Two geographical areas, each within 1/2 mile of The Pennsylvania State University campus, were selected because each contained a high concentration of faculty members and graduate students. One area consisted of a 20-unit private apartment complex and the adjoining square block. The other area consisted of one square block and a three-block continuation of one side of the square. A complete listing of young children in each area was available. Subjects were limited to children of students, faculty members, other professionals, and those with managerial occupations.

A letter was sent to the 29 eligible families in these areas with children between 2 years 6 months and 6 years 5 months of age, asking permission to enlist their children as subjects (see Appendix). Parents were telephoned a few

days later. Twenty-seven families agreed to enlist their 36 eligible children as subjects, and 32 of the children completed the procedures. Two children began, but did not complete the procedure; one, because of an experimenter error, and the other, because she became ill during the second session.

The subjects were listed by age and assigned to the two experimental groups as follows: the first child was chosen at random and assigned as Subject 1 to the 2-stimuli group. The child in the group of remaining available subjects who was closest in age to Subject 1 was designated as Subject 2 and assigned to the 1-stimulus group as matchmate to Subject 1. Subjects 3 and 4 were then chosen from the list of remaining children in the same manner and designated as matchmates, and so on down the list with odd numbered subjects assigned to the 2-stimuli group, paired with even numbered subjects, who were in the 1-stimulus group.

There were 10 boys and 6 girls in each of the two experimental groups. The 16 children in the 2-stimuli group ranged from 34 to 77 months of age, with a mean of 54.3 months. Subjects in the 1-stimulus group ranged from 36 months to 77 months with a mean of 54.6 months. The 16 pairs of matchmates were divided by age into the 8 younger and 8 older pairs. There were then four groups: young 2-stimuli (age 34 to 51 months, mean, 42.9 months); young 1-stimulus (age 36 to 51 months, mean, 42.8 months); old 2-stimuli (age 57 to 77 months, mean, 65.8 months); old 1-stimulus (age 59 to 77 months, mean, 66.4 months).

Apparatus and Stimuli. The apparatus was identical to that used by Berman in the earlier learning set studies. It was a simplified form of the Wisconsin General Test Apparatus (Harlow, 1959), consisting of a gray 5 1/4 x 17 3/4 in. tray with three reward wells, 1 1/2 x 1 1/2 in. wide, 3/4 in. deep, and 6 in. apart from center to center. The wells were cushioned with foam rubber to prevent inadvertent cues from noises.

One hundred and twenty paper stimuli were cut from ready-made printed materials varying in color and pattern. Small pieces were cut, varying in both size and shape, and each piece was mounted on a 3 x 3 in. white cardboard square. Pictures of real objects and meaningful symbols were not used in an effort to avoid stimulus preferences. While the cards were in a face-down position they were randomly selected one at a time and designated in sequence: Problem 1, positive stimulus; Problem 1, negative stimulus; Problem 2, positive stimulus; . . . etc., until two stimuli, each, for the 60 possible problems were selected.

While cards were still face down, one of the borders of each card was randomly selected and designated as the top so

that orientation could be kept constant during presentation to subjects.

A marble was used as a reward for each correct choice.

Procedure. Subjects were given a learning set series of 48 problems in a 2x2x2x2 (Age x Procedure x Reward-Nonreward x Problem Block) design. A different pair of stimuli was used for each problem. The procedure was similar to that used in Berman's previous experiments (Berman, 1965). Subjects were run in separate rooms, each in his home, seated at a table on which the stimulus tray was placed, facing the experimenter. The reward wells were baited while the tray was screened from the subject's view. The instructions were identical to those used in the previous series of experiments. They were given preceding the first problem and were repeated whenever it was thought necessary to direct the child's attention to the problem. The instructions were as follows:

When a single stimulus was presented, "Pick up this card and see if it has a marble under it." When two stimuli were presented, "One of these has a marble under it. Pick the one you think has the marble under it."

After the child's choice the experimenter said "Yes, the marble was under that one, wasn't it?" (Or, "No, the marble wasn't under that one, was it?") A noncorrection method was used.

Trial 1 was the information trial and problem solution could be achieved on trial 2 by responding according to a win-stay, lose-shift principle. Thus, if trial-1 choice was rewarded, then choice of the same stimulus was rewarded on trial 2. If it was not rewarded, then choice of the alternate stimulus was rewarded on trial 2.

The 2-stimuli group was presented with the same two stimuli on both trials of each problem. One stimulus was positive, and the other was negative for both trials of the problem. The subject's choice on the first trial determined whether a particular problem was a reward or a nonreward problem. Twenty-four problems were administered during the first learning session. In the second session a sufficient number of additional problems were given so that each subject was given 24 reward and 24 nonreward problems. (Only data from the first 24 reward problems, and the first 24 nonreward problems were used for analysis.)

The 1-stimulus group was presented with a single stimulus on trial 1 of each problem. On the 24 reward problems the single trial-1 stimulus was rewarded and on the 24 nonreward problems the trial-1 stimulus was not rewarded. On trial 2 the same stimulus was again presented together with

a novel stimulus. If a stimulus was rewarded on trial 1, it was again rewarded on the second trial, and the novel stimulus was not rewarded. If the trial-1 stimulus was not rewarded, the novel stimulus was rewarded on trial 2.

Subjects in both groups received the same pairs of stimuli in the same order for the series of 48 problems and the same stimuli were positive and negative for subjects in both groups, thus controlling for stimulus preferences.

In the 2-stimuli group the subject's choice on trial 1 of each problem determined the order of reward and nonreward problems. Individual subjects in the 1-stimulus group were given reward and nonreward problems in the same order as the subjects in the 2-stimuli group with whom they were paired.

The following procedure was adopted so that opportunities for reinforcement of perseverative position responses were minimal and equal for subjects in both groups. All three positions on the tray (L, M, and R) were used for stimuli. The position of the positive and/or negative stimuli on the 96 successive trials was determined from a list (see Appendix) on which the three combinations of positions (R&L, R&M, and L&M) were randomly distributed over the 96 successive trials, with the limitation that each combination was used 32 times. The position of the rewarded stimulus was determined randomly with the limitations that each of the three positions was used 32 times, but that reward was never in the same position more than three times in succession.

The same list was used for all subjects in both groups. The only difference was that children in the 1-stimulus group received only the positive or the negative stimulus on the first trial of each problem, and the stimulus was in the same position as the stimulus with the same reinforcement value given on that trial to subjects in the 2-stimuli group.

Results

The mean scores of each group are represented in Table 1. Scores are in per cent correct for the first and last 12 of the reward problems and of the nonreward problems. Table 2 presents the summary of an analysis of variance of these scores. There were three significant sources of variance: Reward vs. Nonreward, Presentation Method, and Problem Block.

Reward problems were more difficult than nonreward problems and, as in previous studies, the difference was

Table 1. Group Mean Scores in Percent Correct for Reward and Nonreward Problems

Group	Reward			Nonreward			Combined Problems		
	1st half	2nd half	Sum	1st half	2nd half	Sum	1st half	2nd half	Sum
1 stimulus									
Young	42.7	50.0	46.3	64.6	72.9	68.8	53.6	61.5	57.6
Old	44.8	52.1	48.4	70.8	71.9	71.4	57.8	62.0	59.9
Combined Ages	43.8	51.1	47.4	67.7	72.4	70.1	55.7	61.8	58.8
2 stimuli									
Young	49.0	65.6	57.3	71.9	84.4	78.1	60.4	75.0	67.7
Old	60.4	66.7	63.5	62.5	79.2	70.8	61.5	72.9	67.2
Combined Ages	54.7	66.2	60.4	67.2	81.8	74.5	61.0	74.0	67.5
All Groups Combined	49.2	58.6	53.9	67.4	77.1	72.3	58.3	67.8	63.1

Table 2. Analysis of Variance of Scores for Experiment 1

Source	df	MS	F
Age (A)	1	2,682.8	<1
Presentation Method (PM)	1	244,951.0	6.030[a]
A x PM	1	5,263.5	<1
Between Ss error	28	40,620.1	
Reward-Nonreward (R-NR)	1	1,078,980.5	12.448[b]
Problem Block (PB)	1	289,180.1	13.380[b]
R-NR x PB	1	52.5	<1
A x R-NR	1	33,800.0	<1
A x PB	1	9,180.1	<1
A x R-NR x PB	1	2,646.4	<1
PM x R-NR	1	57,905.0	<1
PM x PB	1	38,201.8	1.768
PM x R-NR x PB	1	7,904.2	<1
A x PM x R-NR	1	40,759.3	<1
A x PM x PB	1	1,396.6	<1
A x PM x R-NR x PB	1	22,522.0	<1
Within Ss error			
error 1 (tests R-NR, A x R-NR, PM x R-NR A x PM x R-NR)	28	86,678.2	
error 2 (tests PB, A x PB, PM x PB, A x PM x PB)	28	21,613.2	
error 3 (tests R-NR x PB, A x R-NR x PB, PB x R-NR x PB, A x PM x R-NR x PB)	28	22,545.7	
Total	127		

[a] $p < .05$

[b] $p < .005$

highly significant. In fact the combined groups solved almost three fourths of the nonreward problems correctly, but performance on the reward problems was close to the chance level. Reward did not significantly interact with any other factor. Thus, reward problems were more difficult regardless of subject's age (A x R-NR) or amount of practice (R-NR x PB).

Presentation Method was a significant source of variance with the 1-stimulus method being more difficult than the 2-stimuli method, regardless of age (A x PM) or level of practice (PM x PB).

Contrary to prediction, there was no interaction between reward and first trial procedure (PM x R-NR).

As expected, performance significantly improved with practice (PB). Practice did not differentially effect the two problems, procedural groups, or age groups (A x PB).

The mean scores of the two age groups were extremely close (c.f. Table 1), and neither age nor any of its possible interactions were significant.

Discussion

Two earlier experiments used procedures which were similar to those used in the present experiment. Levinson and Reese (1967) used a 2-stimuli first trial procedure, and Berman, Rane, and Bahow (in press), a 1-stimulus procedure. Both found significantly more errors following trial-1 reward than nonreward. The present results are in accord with these earlier findings. With each of the two procedures the reward problem was the more difficult of the two problems.

It is of greater interest that significantly more errors were made following first trial presentation of only one of the two problem stimuli than following presentation of both stimuli. Furthermore, type of problem (reward vs. Nonreward) did not interact with type of trial-1 procedure.

It had been assumed that childrens' preference for novel stimuli would influence them to choose the incorrect stimulus on trial 2 of reward problems and, the correct stimulus on nonreward problems, more often than the more familiar alternative stimulus. However, because of differences between the two procedures in the amount of contact subjects had experienced with the more novel of the two second-trial stimuli, an interaction was expected between presentation method and type of problem.

Subjects given the 2-stimuli procedure had seen both stimuli but were given the opportunity to touch, choose, manipulate, and to explore the reinforcement potential of only one of the two stimuli. The stimulus which had been chosen on trial 1 was, thus, the more familiar of the two stimuli presented on trial 2. However, stimulus novelty was expected to be of more importance in determining children's choice when a 1-stimulus method was used, since one stimulus was completely novel on trial 2 of each problem.

Thus, the reward problem was expected to be easier when administered with the 2-stimulus method because the incorrect stimulus was not completely novel, as it was in the 1-stimulus procedure. Conversely, the nonreward problem was expected to be more difficult with the 2-stimuli procedure.

As predicted, reward problems were more difficult for the 1-stimulus group. However, nonreward problems were also more difficult for this group and there was no interaction between type of problem and presentation method.

Observation of subjects' behavior during experimental sessions suggested some reasons for the 2-stimuli group's lack of difficulty with the nonreward problem. Even the youngest children appeared to be highly motivated toward problem solution and attainment of rewards rather than to stimulus exploration. When two stimuli were presented on trial 1 many subjects noticeably oriented toward the alternate (correct) stimulus after an incorrect choice. When a correct choice was made children paid little attention to the other stimulus. Many of the younger subjects began to reach toward the correct stimulus before the stimulus tray was removed following an incorrect choice. Older subjects often described the correct stimulus, as if rehearsing in preparation for a correct choice on the second trial.

Thus, the presence of both stimuli on trial 1 appeared to aid, rather than hinder, members of the 2-stimuli group on nonreward problems, since stimulus generalization in this situation was probably minimal. The advantage of seeing both stimuli on trial 1 seemed to offset any possible disadvantage which might be due to the fact that the correct trial-2 stimulus was not completely novel (as it was for the 1-stimulus group).

There was little difference between scores of the two age groups and, unlike Cross and Vaughter's results, no interaction was found between age and type of problem. Cross and Vaughter's older subjects (4 1/2 to 6 years) did better on reward than on nonreward problems. In the present experiment both age groups made fewer errors on the nonreward problem. Indeed, there is no suggestion from

either the present experiment, Berman's earlier experiments (Berman, 1965; Berman, Rane and Bahow, in press), or the Levinson and Reese study (1967), that any age group, from 2 1/2 through 10 years, solves the reward problem more readily than the nonreward problem. Although there are several procedural differences between these experiments and the Cross and Vaughter study the major difference was that Cross and Vaughter compared the performance of a group learning only reward problems with another group learning only nonreward problems. The other experiments compared reward scores with nonreward scores earned by the same group of subjects. The subjects learning both problems had to learn the win-stay, lose-shift principle and to respond accordingly. Cross and Vaughter's subject had to learn either to consistently choose the novel stimulus or to consistently choose the familiar stimulus. Their younger subjects learned to choose the novel stimuli more easily than the familiar stimuli, and their older subjects, the opposite.

In Berman's earlier series of experiments stereometric junk stimuli were used which were varied on many dimensions. In the present experiment patterned stimuli were used. A comparison was made between overall scores of the four 4-year-olds in the 1-stimulus group and the eight 4-year-olds who learned similar problems in Berman's earlier experiment (Berman, Rane and Bahow, in press). There was no significant difference between the scores of the two groups of subjects ($t = .085$, $df = 10$, $p < .9$).

A survey of the 2-stimulus group's first-trial choices did not reveal any stimulus characteristics which consistently led to stimulus preference. However, strong position preferences were evident. There were 19 problems on which at least 12 of the 16 subjects in the group chose the same stimulus. Sixteen of these problems involved the middle position and on 15 of the 16 problems the stimulus in the middle position was preferred on the first trial, and the frequency of choice of the middle position significantly differed from chance (Chi Square = 5.565, $df = 1$, $p < .02$). However, although there were strong position preferences the children did respond more often to the stimulus rather than the position rewarded on trial 1. There were three problems on which the first-trial stimulus occupying the middle position was correct, but the stimulus occupying the middle position on trial 2 was incorrect. The 32 subjects made an incorrect trial-2 choice of the middle 54 out of a possible 96 times. That is, they chose the middle stimulus more often than not, but not significantly more often than chance (Chi Square = .523, $df = 1$, $p < .50$). Children chose the middle significantly more often than chance on trial 2, when the middle stimulus was incorrect on trial 1, but correct on trial 2. They made a correct choice of the middle stimulus on trial 2 75 out of a possible 96 times (Chi Square = 15.293, $df = 1$, $p < .01$). A comparison

between the number of times the middle stimulus was chosen on the two types of problems shows that the children chose the middle significantly more often when the stimulus occupying the middle on trial 1 was incorrect, but the stimulus in that position on trial 2 was correct (Chi Square = 9.450, df = 1, $p < .01$).

Position preferences were equally strong in the two groups of subjects. There were nine problems in which the middle position was used on both trials 1 and 2. Data was not recorded for all of the subjects on one of these problems (Problem 46) because for some it was among the first 24 reward, or 24 nonreward problems. On the remaining eight problems the 16 subjects in the 2-stimuli group chose the middle trial-2 stimulus 79 out of a possible 128 times, and the subjects in the 1-stimulus group chose the middle stimulus precisely the same number of times.

EXPERIMENT 2

Introduction

The second experiment was designed to compare the effects of two types of novelty on children's choice behavior. Two different procedures were followed. In both, a familiar stimulus with ambiguous reinforcement potential was in competition with a novel stimulus for the subject's choice. Two degrees of exposure to the familiar stimulus were utilized and in each case children were rewarded for choice of the familiar stimulus on the choice trial of each problem. A different set of stimuli were used for each problem.

Procedure A: On each problem children were asked to choose between a novel stimulus and a familiar "ambiguous" stimulus which had been presented alone for either 2 or 4 consecutive trials. The familiar stimulus was rewarded on half of the single presentations and nonrewarded on the remaining ones. It was therefore considered to have an ambiguous reinforcement history.

Procedure B: In this procedure the stimulus was familiar in the sense that subjects was given 2 or 4 visual exposures to the stimulus, but there was no opportunity to choose the stimulus, to handle it, or to see if its choice was rewarded. Instead the "ambiguous" stimulus was merely present while the subject chose between two other (choice) stimuli. A different set of choice stimuli was used on each trial but the ambiguous stimulus remained the same throughout a problem. The subject was rewarded for his choice on half the trials and nonrewarded on the remaining trials of each problem regardless of his choice.

On the last trial the subject was asked to choose between the familiar (ambiguous) stimulus and a novel stimulus.

It was expected that subjects in Group B would choose the familiar stimulus significantly more often than subjects in Group A. In both procedures a familiar stimulus with ambiguous reinforcement potential was in competition with a completely novel stimulus. However, Group B had not had an opportunity to manipulate the stimuli or to see if reward was associated with the stimuli and, in this sense, the ambiguous stimulus was less familiar to Group B than to Group A.

If curiosity or an exploratory tendency is conceptualized as a drive, it can be hypothesized that successive exposures to a stimulus which cannot be manipulated or explored may arouse this drive. Group B would choose the familiar ambiguous stimulus (rather than the novel stimulus) more often after 4 exposures than after 2. The reverse would be predicted for Group A in which the drive to explore would be more fully satiated after 4 exposures than after 2.

It should be noted that the above hypotheses differ from those which might be generated from a traditional S-R theory of reinforcement. According to traditional Stimulus-Response theory the effect of each reward and nonreward would depend on initial habit strength, and the effects of each might not be equal. If initial habit strength were known an S-R theorist might predict which of the two stimuli (familiar or novel) Group A would choose after an equal number of rewarded and nonrewarded presentations of the familiar stimulus. In Group B excitation from reward, and inhibition from nonreward, of the two choice stimuli would generalize to the ambiguous stimulus which is present on each trial. Assuming no systematic difference in initial habit strength between the two groups, the effect of number of exposures would be in the same direction for Groups A and B. However, there would be a greater difference between 2 and 4 exposures for Group A, since for Group B the effects of reward and nonreward would be from generalization alone, and diminished.

There is little research which is directly related to the proposed experiment. The effects of rewarded or nonrewarded presentations of a stimulus prior to a choice trial have been discussed earlier (Berman, 1965; Berman, Rane and Bahow, in press; Cross and Vaughter, 1966).

In another experiment Lipsitt (1962) gave first grade children one of several different types of pretraining experiences prior to performance on one color discrimination problem. Two groups each received 20 rewarded presentations of one of the two color stimuli to be used. A group which received presentations of the stimulus which

was subsequently the correct choice made more (but not significantly more) errors than the group which received rewarded presentations of the stimulus which was to be incorrect. Thus, as many as 20 rewarded presentations did not influence children to choose a familiar stimulus when it was in competition with a novel stimulus.

The experiments discussed have used either reward or nonreward, but not both, in all the presentations of a single stimulus prior to presentation together with a novel stimulus.

Although subjects were rewarded for choice of the familiar stimulus in each problem, Experiment 2 is not designed as a learning study but, rather, as a test of the aspects of familiarity and novelty which influence choice behavior. It is known, however, that monkeys can be trained to choose either the novel or the familiar stimulus in each problem of a series (Riopelle, 1955; Brown, Overall, and Blodgett, 1959), if given a sufficient amount of training.

Several studies with monkeys use a choice situation and an ambiguous, previously unchosen stimulus. However, none have made the comparisons proposed in this study. Leary, in two experiments (1956, 1958), found that monkeys tended to choose a previously unchosen negative stimulus, which had been presented on the preceding trial, even when it was paired with a novel stimulus. He concluded that the unchosen negative object gained in attractiveness. Moon, in an unpublished experiment cited by Leary (1956), had similar results and stated that only actual choice of a negative stimulus seemed to create avoidance.

These experiments indicated that monkeys tend to choose the as-yet-unchosen stimulus, even in preference to the completely novel stimulus. It was not known whether children would respond in a similar manner.

Method

Subjects. The subjects were drawn from the same population as those in Experiment 1, but only children between 6 years and 6 months and 9 years and 11 months were included. The parents of 27 children from 18 families agreed to enlist their children as subjects. Twelve children were chosen randomly and assigned to Group A and 12, to Group B. The subjects in each group ranged from 81 to 119 months. The mean age of Group A was 93 months and, of Group B, 92 months.

Apparatus and Stimuli. The apparatus was the same as that used in Experiment 1 and the stimuli were constructed in the same manner.

The 192 cards used in Experiment 2 were each randomly chosen and marked on the back in sequence: Problem 1 (a short problem), first two stimuli - Choice stimuli for trial 1, second two stimuli - choice stimuli for trial 2, the next stimulus-ambiguous stimulus for trial 3, and the last stimulus - novel stimulus for trial 3. Stimuli for the remaining 23 problems were selected in a similar fashion except that for long problems four pairs of choice stimuli were selected for trials 1 through 4, and an ambiguous and a novel stimulus were then selected for the last trial. Stimulus orientation was determined as in Experiment 1, and the back of each card was so marked. Marbles were used as rewards.

Procedure. The general procedure was the same as that used in Experiment 1. Each of the two groups was given a learning set series of 24 problems with a different procedure. Both groups were given 12 3-trial, and 12 5-trial problems in a single session.

On each problem subjects from Group A were given repeated presentations of a single stimulus before the last trial, on which they were asked to choose between it and a novel stimulus. Half the problems were 3-trial problems and the remainder, 5-trial problems. On half of the trials preceding the choice trial of each problem the single stimulus was rewarded, and on the remaining half it was not rewarded. On the choice trial of each problem the familiar stimulus was positive, and the novel stimulus was negative. The instructions for this group were, on all trials but the last: "Pick up this card and see if it has a marble under it." On the last trial: "One of these cards has a marble under it. Pick the one you think has the marble under it. Yes, the marble was under that one, wasn't it?" (Or, "No, the marble wasn't under that one, was it?")

Group B used the same cards as Group A for both the familiar and the novel stimuli on corresponding problems in the sequence of 24 problems. However, on the trials preceding the choice trial of each problem two stimuli were present in addition to the familiar stimulus. These two stimuli (choice stimuli) were changed from trial to trial, while the familiar stimulus changed only from problem to problem. On trials 1 and 2 of the 3-trial problems, and on trials 1 through 4 of the 5-trial problems, subjects were asked to choose between the two changing stimuli, and either choice was rewarded on half of these trials, and nonrewarded on the remaining half, in predetermined order. However, subjects had no opportunity to choose the familiar stimulus until the last trial of each problem. The

familiar stimulus was then paired with a novel stimulus and choice of the familiar stimulus was rewarded.

The instructions for Group B were, on all trials but the last: "One of these two cards has a marble under it. Just look under one of these two cards." (The experimenter pointed to the choice cards.) On the last trial: The instructions were the same as those for Group A for the last trial.

The order of rewarded and nonrewarded trials on the first 2 trials of 3-trial problems and on the first 4 trials of 5-trial problems was determined randomly with the restriction that on each problem half of these trials be rewarded and half, nonrewarded (see Appendix). The order of these trials for each problem was the same for both groups of subjects.

The position of the familiar and novel stimuli on each trial of each problem was also the same for members of both groups. Position was randomly determined with the restrictions that the familiar stimulus would be in each position (L, M, and R) an equal number of times, but not in the same position for more than three successive trials. (See Appendix for list of rewarded and nonrewarded trials and position of stimuli.)

For half of the subjects in each group the order of the 3-trial and 5-trial problems were as given in the list. For the remaining subjects the order of long and short problems was reversed, and these subjects were given the problems in the following order: 2, 1, 4, 3, 6, 5, 8, 7, 10, 9, 12, 11, 14, 13, 16, 15, 18, 17, 20, 19, 22, 21, 24, 23.

Results

Table 3 presents the mean scores for the two groups of subjects for the longer and the shorter problems in the first and second half of the series of problems. Only the data from the first half of the problem series were submitted to analysis of variance because half of the children in Group A had perfect scores in the second half of the series. Inclusion of these data would have resulted in heterogeneity of variance. A summary of the analysis is presented in Table 4.

Group A chose the correct (ambiguous) stimulus more often than did Group B. The difference was significant in the first half of the series (Procedure, Table 4), and pronounced in the second half of the series.

Table 3. Group Mean Scores in Percent Correct for Long and Short Problems

	Group A	Group B
First Half		
Long Problems	52.1	29.2
Short Problems	64.6	41.7
Both Problems	58.3	35.4
Second Half		
Long Problems	85.4	56.3
Short Problems	83.3	56.3
Both Problems	84.4	56.3
Both Halves		
Long Problems	68.8	42.8
Short Problems	74.0	49.0
Both Problems	71.4	45.9

Table 4. Analysis of Variance of Scores for the First Twelve Problems in Experiment 2

Source	df	MS	F
Procedure (Groups A vs. B)	1	15.225	4.985[a]
Between Ss error	14	3.054	
Exposures (Long vs. Short)	1	4.500	3.112
Procedure x Exposures	1	0.000	<1
Within Ss error	14	1.446	
Total	31		

$p < .05$

However, choice of the ambiguous stimulus was rewarded, and inspection of the data from the first few problems indicates that the difference between the two groups is most likely due to a difference in learning under the two different conditions, rather than to a difference in initial tendency to choose the ambiguous stimulus. On the first few problems children from both groups chose the novel stimulus most often and Group A chose the novel stimulus at least as often as did Group B. On the first problem all of the children in Group A, and six of the eight children in Group B, chose the novel stimulus. On the second problem five of the eight children in Group A, and half of the children in Group B, chose the novel stimulus.

In the first half of the series the children tended to make fewer correct choices (more novel choices) on the longer problems, but the difference between long and short problems did not reach significance (Table 4, Exposures). On the second half of the series there was almost no difference between scores on the long and the short problems (see Table 3).

The analysis of variance showed no interaction between the groups and problem length (Table 4, Procedure x Exposures) in the first half of the problems, and there was no suggestion of such an interaction in the remaining problems (see Table 3).

Discussion

Neither of the two hypotheses of the experiment were confirmed. Subjects in Group B did not choose the familiar stimulus more often than subjects in Group A. The reverse was true but, since children were rewarded for choice of the ambiguous stimulus, the difference between groups was probably due to more efficient learning in Group A. This might well be the case because the learning situation was complicated for Group B by the presence of the "choice stimuli" on trials prior to the last trial of each problem.

On the initial problems of the series children in Group B chose the familiar stimulus at least as often as did the children in Group A. On these problems both groups tended to choose the novel stimulus rather than the more familiar ambiguous stimulus. In this respect they were unlike Leary's monkeys (Leary, 1956, 1958) who chose a previously presented, but unchosen, stimulus in preference to a completely novel stimulus. It is possible that a younger group of children might choose the ambiguous stimulus more often, given procedures similar to those administered to Group B.

An interaction had been expected (Procedure x Exposures) based on the assumption that curiosity or an exploratory drive would be aroused in Group B by successive exposures to a stimulus which could not be manipulated or explored. Thus, Group B was expected to choose the familiar stimulus more often on 5-trial problems compared with 3-trial problems. On the other hand, it was assumed that the exploratory drive would be satisfied more fully for Group A after more frequent handling of the familiar stimulus on 5-trial problems than on 3-trial problems.

The results showed no such effect. Subjects chose the familiar stimulus somewhat, but not significantly, more often on 3-trial problems in the first half of the series only, and this was so for both groups.

Two dimensional stimuli differing only in pattern and color were used for this experiment. Motivation to explore the stimuli may well be based on the nature of the stimuli themselves and, in this case, the stimuli might not have been interesting enough to arouse curiosity or an exploratory drive. If stimuli with considerable tactual appeal had been used, such as three-dimensional or textured stimuli, children in Group B might have been motivated by a desire to explore previously exposed but unchosen stimuli.

An alternate prediction might be generated from a traditional Stimulus-Response theory of reinforcement. If there were no systematic differences between Groups A and B in initial habit strength the effect of number of exposures would be expected to be in the same direction for the two groups, but the difference between long and short problems would be greater for Group A. The difference would be diminished for Group B since the effects of reward and nonreward on the familiar stimulus would be from generalization, rather than from direct reward and nonreward. It should be noted that the difference between scores on the 3- and the 5-trial problems was the same for both groups, and the data offer no support for this alternate prediction.

Conclusions and Recommendations

Experiment 1 compared two types of procedures for trial-1 stimulus presentation in their effect on performance following reward and nonreward. The results agreed with previous studies using one or the other, but not both, of the two procedures (Berman, 1965; Berman, Rane, and Bahow, in press; Levinson and Reese, 1967). With both procedures significantly more errors were made following reward than following nonreward.

An interaction between Presentation Method and Reward-Nonreward was expected based on the assumption of additional novelty for the incorrect trial-2 stimulus on the reward problem and the correct trial-2 stimulus on the nonreward problem. Instead the 2-stimuli group performed better than the 1-stimulus group on both problems. It appeared that on the nonreward problem the additional information in the 2-stimuli procedure was sufficient to offset the disadvantage of the lesser novelty of the correct trial-2 stimulus.

Children performed better on the second half of the problem series than on the first half. Performance of the two age groups did not differ significantly.

Experiment 2 was designed to compare the effects of two types of novelty on children's choice behavior. It was assumed that curiosity or desire to explore the stimuli could be aroused as a drive, and that exposure on successive trials to a stimulus which could not be manipulated or explored would arouse this drive.

The hypotheses of Experiment 2 were not confirmed. The group which was repeatedly required to handle the familiar stimuli made significantly more choices of this stimulus than the group which had been exposed to, but not allowed to handle, the familiar stimulus. This was not the case on initial trials, however, and the effect was probably due to more efficient learning in the former group. There was no interaction between Procedure and Exposures, and the group which was not allowed to handle the familiar stimulus before the choice trial did not choose the familiar stimulus more often on the longer problems than on the shorter problems.

The degree to which novelty operates, either to the advantage or disadvantage of learning, seems to depend partly on the nature of the stimuli, as well as the procedure and the age of the subjects. In the present experiments two-dimensional patterned stimuli were used which seemed to have minimal tactual appeal for subjects. Further research is needed in which the characteristics of stimuli are varied and the effects on choice behavior and learning of young children may be more thoroughly studied.

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APPENDIX

Letter Sent to Parents of Prospective Subjects for Experiments 1 and 2

Dear _____:

With the support of the United States Office of Education we have been conducting a series of studies dealing with children's learning processes. In particular we are interested in those aspects of learning situations which lead to common errors. The studies were begun at the University of Wisconsin using children who lived near the campus as subjects.

We are looking for a group of children, 2 1/2 to 10 years old, similar to the Madison, Wisconsin children who participated in our earlier studies, and we are asking your permission to enlist your child, _____, as a subject.

The experimenter procedure is a simple one in which children choose between several picture cards in a guessing game.

We will be telephoning you in a few days to discuss our research more fully with you and to answer any questions you may have.

Sincerely yours,

Phyllis Berman, Ph.D.
Assistant Professor

Experiment 1. Position of stimuli on the two trials of each problem. (Position was in relation to the experimenter.) Position underlined was rewarded.

Problem:

1.	R L L M	17.	R M R L	33.	R M R L	49.	L M R M
2.	L M R L	18.	L M R M	34.	R L R M	50.	R L L M
3.	R M R M	19.	R L R L	35.	R L R M	51.	R L R M
4.	L M L M	20.	R M L M	36.	L M L M	52.	R M R L
5.	R L R M	21.	R L R L	37.	R M R L	53.	L M R L
6.	R L R L	22.	R M R M	38.	L M R L	54.	R M L M
7.	L M R M	23.	R L L M	39.	R M R L		
8.	R M R L	24.	L M L M	40.	L M R L		
9.	R M L M	25.	R M R M	41.	R M R M		
10.	L M R L	26.	R L L M	42.	R L L M		
11.	R M L M	27.	R L R M	43.	R M L M		
12.	L M L M	28.	R L L M	44.	R L R M		
13.	L M R M	29.	R M L M	45.	R M R L		
14.	R M R L	30.	R M L M	46.	R M L M		
15.	R M L M	31.	R L R L	47.	L M R M		
16.	R L R L	32.	L M L M	48.	L M R L		

Experiment 2. Position and reward value of stimuli.

Problem:

1.

trial:	R	M	L
1		+A	
2			-A
3*	+A	-N	

2.

	R	M	L
1	-A		
2		+A	
3	+A		
4		-A	
5*	-N	+A	

3.

	R	M	L
1	+A		
2			+A
3			-A
4	-A		
5*		+A	-N

4.

	R	M	L
1	-A		
2			+A
3*	-N	+A	

5.

	R	M	L
1		-A	
2		+A	
3*		-N	+A

6.

	R	M	L
1			+A
2	+A		
3			-A
4	-A		
5*	+A		-N

7.

	R	M	L
1			+A
2		-A	
3*	+A		-N

8.

	R	M	L
1		-A	
2			-A
3			+A
4	+A		
5*		-N	+A

9.

trial:	R	M	L
1	+A		
2	-A		
3*	-N		+A

10.

	R	M	L
1		+A	
2		-A	
3	-A		
4		+A	
5*		-N	+A

11.

	R	M	L
1	-A		
2			+A
3*		+A	-N

12.

	R	M	L
1		-A	
2			+A
3	-A		
4	+A		
5*	-N		+A

13.

	R	M	L
1	+A		
2		-A	
3			+A
4			-A
5*	-N	+A	

14.

	R	M	L
1	-A		
2	+A		
3			+A
4			-A
5*	+A		-N

15.

	R	M	L
1	+A		
2		-A	
3*	+A	-N	

16.

	R	M	L
1		-A	
2			+A
3*	-N	+A	

*Choice trial on each problem.

17.

trial:	R	M	L
1	+A		
2			-A
3		-A	
4	+A		
5*		+A	-N

18.

	R	M	L
1	+A		
2		-A	
3*	+A	-N	

19.

	R	M	L
1			-A
2		+A	
3*	-N	+A	

20.

	R	M	L
1			+A
2	-A		
3			+A
4		-A	
5*	+A		-N

21.

	R	M	L
1		-A	
2			+A
3*	+A	-N	

22.

	R	M	L
1		-A	
2	+A		
3			-A
4			+A
5*	+A		-N

23.

	R	M	L
1			+A
2			-A
3		-A	
4			+A
5*	+A	-N	

24

	R	M	L
1		+A	
2	-A		
3*	-N		+A

*Choice trial on each problem.